

MANN+HUMMEL Diesel Particulate Filter SMF®-AR

New filter technology for diesel engines



Diesel particulate filtration – trends

The engines future

In recent years the robust and economic nature of the diesel engine has increased its popularity as a drive unit. Today diesel engines are the standard choice for mobile machinery used in the construction industry and agriculture. Yet despite the most modern engine technology, particle emissions remain an issue for the diesel engine. Scientific research indicates that engines without a diesel particulate filter are a health risk.

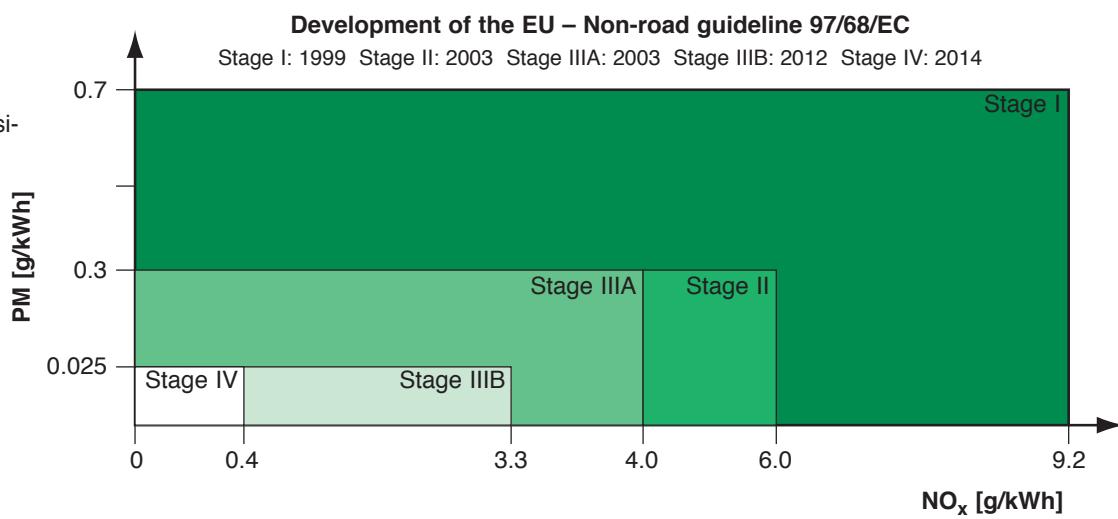
According to the World Health Organisation (WHO) and the US Environmental Protection Agency, particulates from diesel engines are today responsible for 5% of all respiratory cancer. Environmental and political pressure and regulations governing the workplace have therefore made it a top priority to use diesel particulate filters to remove the fine particulates from exhaust emissions created by diesel engines.



Market development

Diesel engines make an invaluable contribution towards achieving environmental protection targets. In contrast to petrol engines, due to their low fuel consumption they produce approximately 20% less carbon dioxide. However, for many years it has been clear that the soot particles generated by diesel engines contribute towards environmental pollution and are a risk to health. The European 97/68/EC guideline for engines installed in non-road mobile machinery requires a value of 0.025 g/kWh for the particle emissions of diesel engines.

Today, Swiss legislation already requires installation of a filter in each construction machine. In order to achieve the emission values, MANN+HUMMEL recommend the use of a diesel particulate filter.



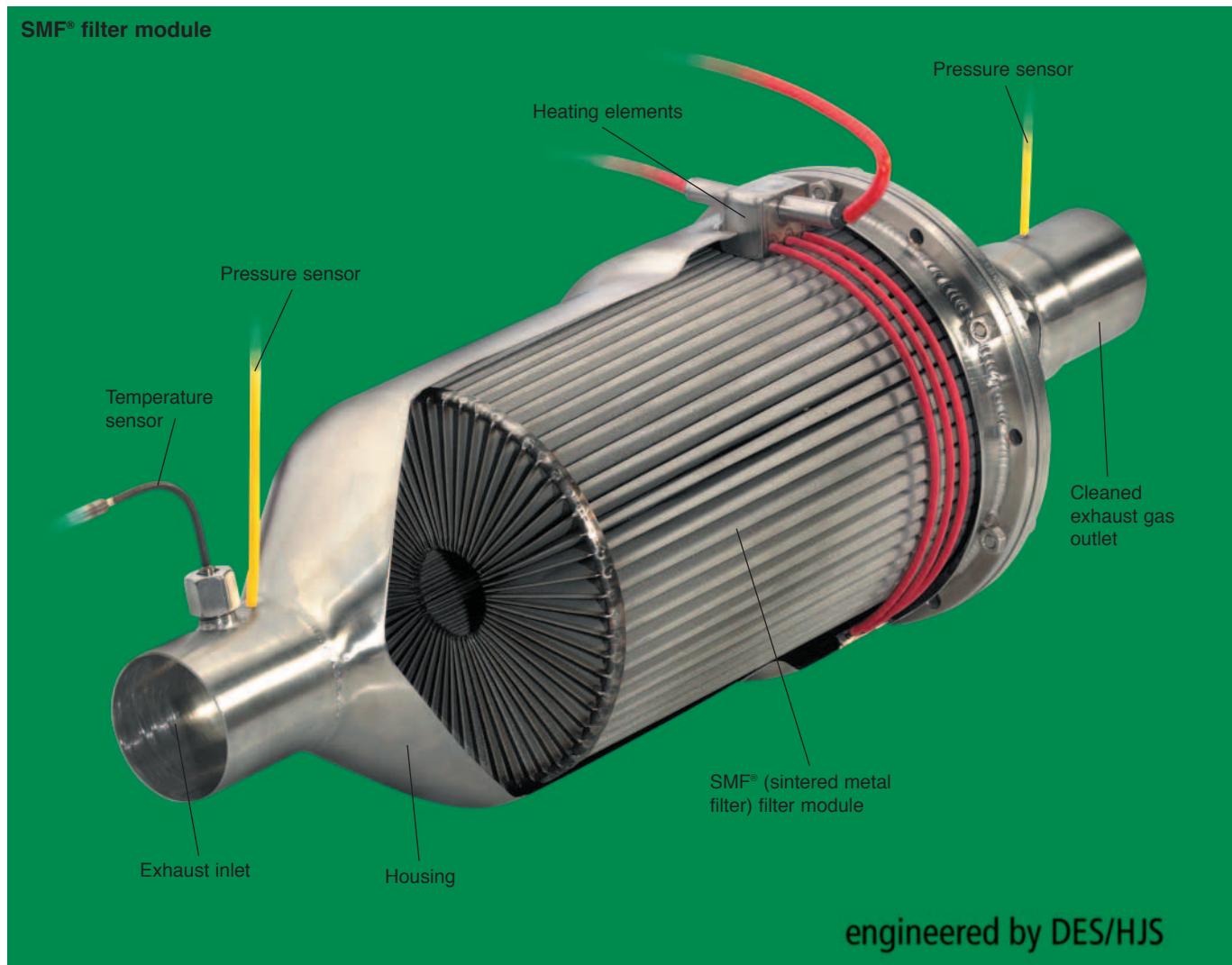
SMF®-AR: Innovative filter technology with sintered metal

The SMF®-AR filter with a sintered metal element from MANN+HUMMEL breaks new ground in the field of exhaust gas cleaning for diesel engines. The design of the SMF®-AR with its conical filter channels and the choice of material used give the filter considerable advantages over other diesel particulate filters that are available on the market. The service life of the filter is approx. 2.5 times longer than conventional systems which use ceramic elements. In addition, it is easy to clean and maintain.

This filter technology offers the ideal conditions for the fitting of filters in future to all diesel engines used in commercial vehicles, construction machines and stationary plants. The SMF®-AR is suitable for OEM products and the retrofit market.

Advantages of the SMF®-AR filter

- 99% filter efficiency
- Long service life thanks to maximum ash holding capacity
- Low costs for cleaning and maintenance
- Active regeneration
- Suitable for a wide range of exhaust gas temperatures
- Excellent inflow and flow through
- Low exhaust gas back pressure
- Modular, self-supporting design
- Easy adaptation to different installation spaces
- Low cost canning
- Easy recycling



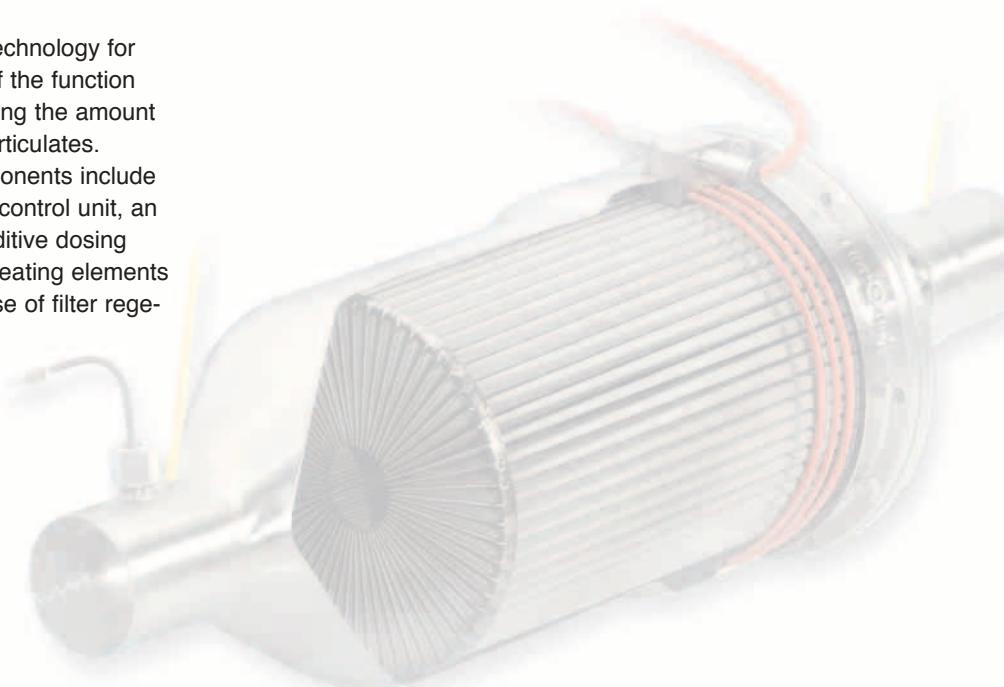
engineered by DES/HJS

SMF®-AR: Reliable regeneration at low exhaust gas temperatures

Characteristics

MANN+HUMMEL SMF®-AR sintered metal filters are suitable for use at low exhaust temperatures. The filters loaded with diesel particulates are actively regenerated. The regeneration process functions under all engine operating conditions. The SMF®-AR system consists of a diesel particulate filter equipped

with sensor technology for supervision of the function and determining the amount of trapped particulates. System components include an electronic control unit, an automatic additive dosing system and heating elements for the purpose of filter regeneration.



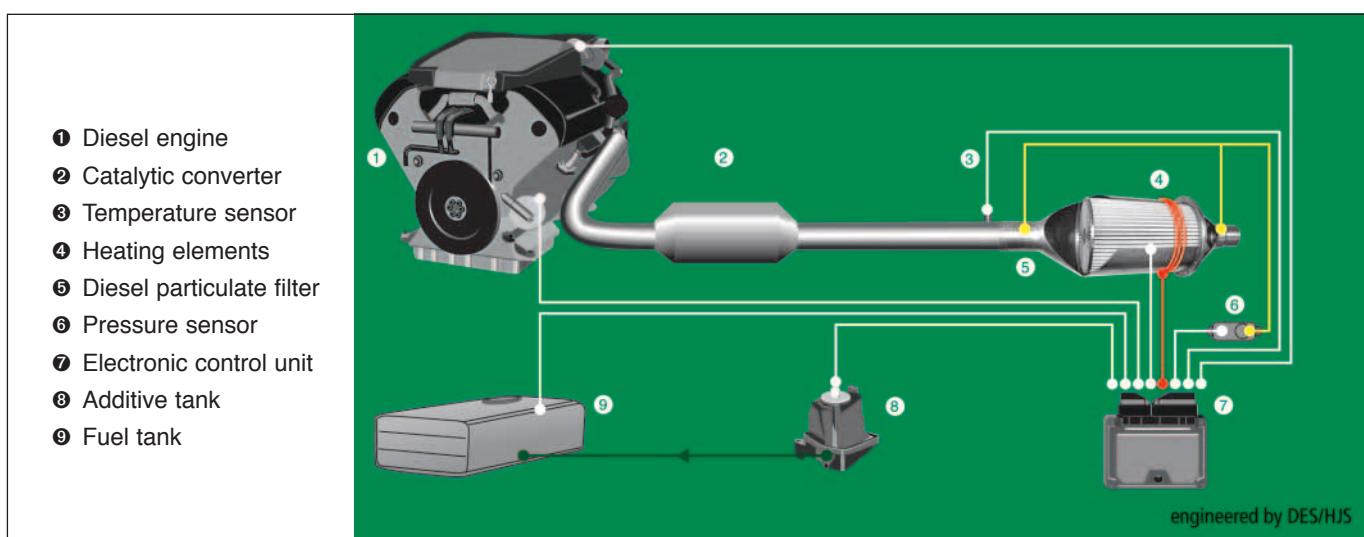
Principle of the SMF®-AR system

During the process of active regeneration in the sintered metal filter, the diesel particulates are trapped until a specific volume of soot is deposited on the filter material which is ideal for electrical regeneration. Then the trapped diesel particulates are burned off. The burning of the diesel particulates in the SMF®-AR system is made through heat radiated from

the heating elements without physical contact and is therefore low-wear. Three heating elements spaced 10 mm apart surround the complete filter and ensure comprehensive and consistent heating of the irradiated diesel particulates.

The extremely low material mass of the heating elements allows the temperature to rise very quickly. This means that

even under extreme conditions the fully-automatic burning of the layer of diesel particulates can take place within a heating period of just 2 minutes. Approximately 10% of the filter casing surface area is irradiated and this initiates the burning of diesel particulates over the complete filter surface area. During the process the machine continues operation.



SMF®-AR Specifications

SMF®-AR Systems

Complete systems				
Surface area [m ²]	Length [mm]	ø [mm]	Module [mm]	Application examples
1.8	525	180	251.5 x d 180	Forklifts, compressors, special machines
2.7	660	180	382.5 x d 180	Construction machines, forklifts, tractors
3.8	735	281	392 x d 281	Tractors, construction machines
5.4	approx. 600	319	301 x d 319	Agricultural machines, construction machines

MANN+HUMMEL configures the systems individually to meet customer requirements.

Systems for higher power classes and other geometries are available on request.

Sintered Metal Element types



engineered by DES/HJS

Critical factors

The use of high-alloy corrosion resistant metal powders in combination with reinforcing base materials of the same composition guarantees a long life for our filter material. Sintered metal technology allows the creation of a defined pore size with high porosity. The result of our development is a filter efficiency level of 99% with low

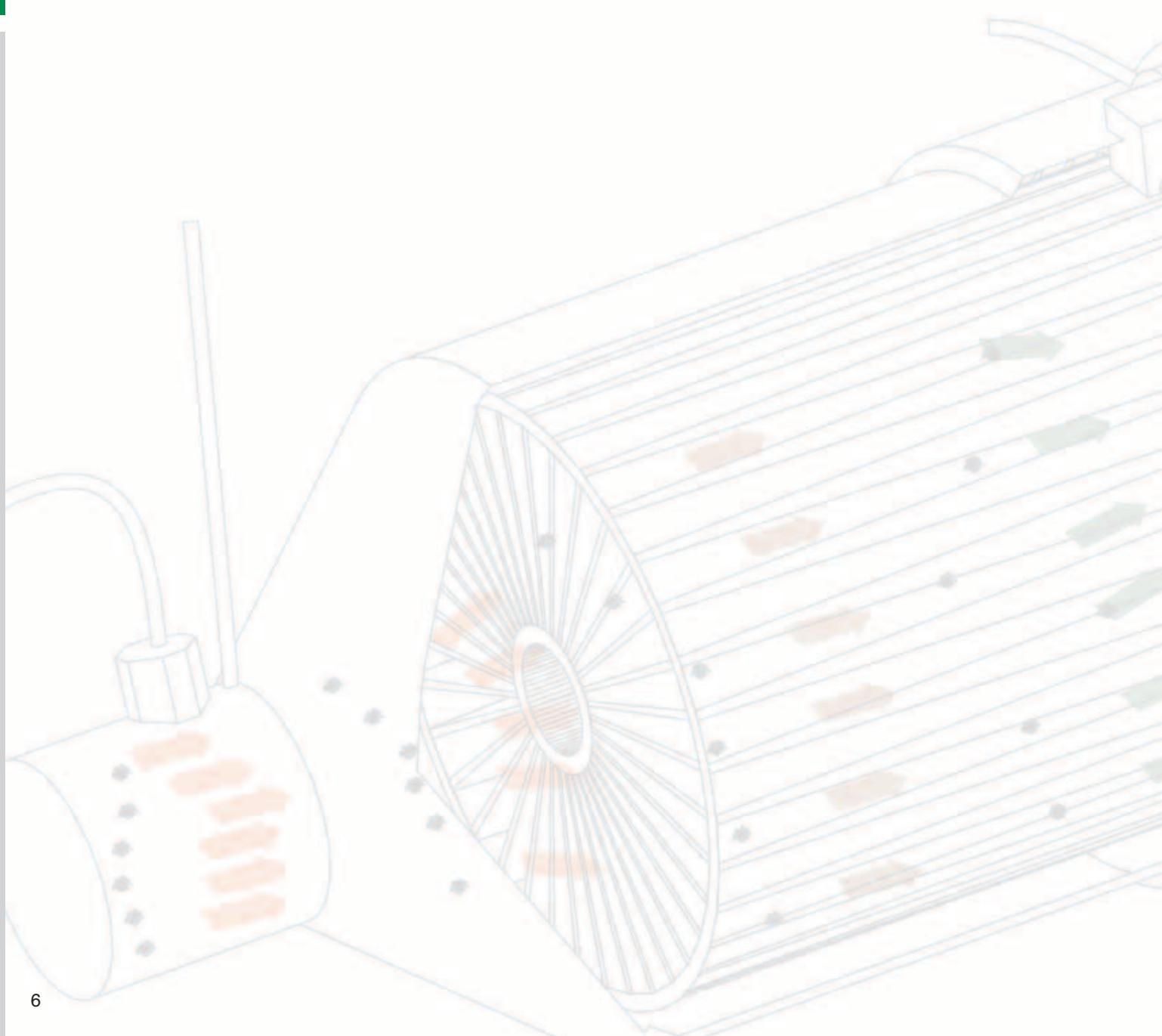
pressure drop and very flexible forming possibilities for the filter medium. Good heat dissipation and metallic elasticity protect the filter from damage due to thermal regeneration and enable high diesel particulate loads with low pressure drop. The self-supporting design of the filter does away with the need for a honeycomb structure. This

leads to efficient use of installation space and reduces costs and the time required for fitting. Another advantage is that dangerous fibres are not emitted from ceramic matting. The high degree of flexibility in the forming of the material enables the design of a filter system which offers the ideal storage of engine and additive ashes. In addition,

the inflow resistance is matched to the conditions in the exhaust gas system. Flat feed angles and large flow surfaces on the engine side reduce back pressure to the minimum which is technically possible. Cleaning the filter of non-combustible residue is easy to accomplish, but is usually only required after a very long operation time.

SMF®-AR Specifications

Material description	STM53W
Composition	
Base material:	High-temperature chrome-nickel steel
Metal powder:	Ultra fine metal powder from heat-resistant chrome-nickel steel
Characteristics	
Mass per unit area:	1,600 g/m ²
Thickness:	0.38 mm
Porosity:	45% incl. supporting structure
Pore size:	10 µm mean flow pore size (MFP)
Permeability:	100 m ³ /(m ² /h) at 200 Pa
Differential pressure to air:	>95%, mass of diesel particulates
Filter efficiency:	>99%, quantity of particles
Breaking elongation:	40% (x axis), 20% (y axis)
Melting point:	1,360 °C
Thermal shock rate:	>1,000 K/s
Continuous duty temperature:	850 °C
Diesel particulate load:	20-25 g/m ²



Glossary

Canning

Canning is used to describe the manufacture and provision of casings for diesel particulate filters (DPF[®]) as a component part of a complete exhaust gas system, partly including the necessary exhaust pipes.

CRT[®]

CRT[®] stands for Continuously Regeneration Trap – and describes a combination of a diesel oxidation catalytic converter (DOC) with a diesel particulate filter (ceramic or sintered metal).

DPF[®]

DPF[®] stands for diesel particulate filter. DPF[®] is a registered trademark of the German company HJS Fahrzeugtechnik.

EPA

The US environmental protection agency, often abbreviated to EPA or also US EPA is an organisation of the US government dedicated to environmental protection and protection against risks to human health. It develops and enforces implementation of the environmental protection regulations.

Fine particulates

Airborne contaminant particles with an aerodynamic diameter of fewer than 10 µm (PM₁₀).

NO_x

Nitrogen oxide (NO_x) is generated in combustion processes with high temperatures, for example in vehicles, power stations and industry. Nitrogen oxide is dangerous to human health. A special aspect of nitrogen oxide in connection with modern engine technology is the conflict between reduced consumption and reduction of NO_x emissions. Efficient engines have a high combustion temperature and therefore produce more NO_x.

Off-highway

Off-highway refers to the use of systems in vehicles not registered to drive on roads (e.g. construction machines, forklifts, special vehicles).

Particles

Since the US introduced limits for particle emissions in 1972, particles are defined by the method of measurement. According to the measurement technique defined by the US EPA and EU directive 88/77/EEC, particles are solid and gaseous exhaust components which can be separated from exhaust gas diluted with filtered ambient air using a test filter at a defined maximum temperature of 51.7 °C.

PM₁₀

Particles that pass a size-selecting air inlet with an aerodynamic diameter of 10 µm are characterised by a separation efficiency of at least 50%. Similarly, "particulate matter" = fine dust or aerosols.

Retrofit

Exhaust gas cleaning system fitted after the system with the diesel engine has been delivered (e.g. bus, construction machine) to the customer.

SMF[®]-AR

SMF[®] with active regeneration, whereby active regeneration currently refers to so-called "thermoelectric regeneration". This is a regeneration process specially developed for the SMF[®] which uses a heating unit, an additive dosing system and a customised electronic control unit (ECU).

VERT

VERT stands for the reduction of emissions from machines used in tunnel construction. VERT is a project conducted by the Swiss institute for accident protection (SUVA), the Munich civil engineering association (TBG), the Austrian general accident insurance institute (AUVA) and the Swiss federal office for the environment, forest and countryside (BUWAL).



- MANN+HUMMEL company
- Joint venture company

MANN+HUMMEL Industrial Filters

The MANN+HUMMEL Group is an international company with its headquarters in Ludwigsburg, Germany. The group employs approx. 9,500 people worldwide at more than 40 locations.

The company develops, produces and sells technically complex components for the

automotive industry and many other fields. A key area is high quality filtration products for vehicles, engines and industrial applications. The OEM business with global market leaders and producers of vehicles, machines and installations defines the quality and performance of the group. Filters for the

international aftermarket are sold under numerous international brands as well as under the MANN-FILTER brand.

The Industrial Filters Business Unit with its headquarters in Speyer, Germany is specialised in meeting the requirements of off-highway vehicle

and - engine applications, compressed air and vacuum technology, mechanical engineering and plant construction. For these and other industrial fields MANN+HUMMEL Industrial Filters offer high performance products for the filtration and separation of air, gases and liquids.

